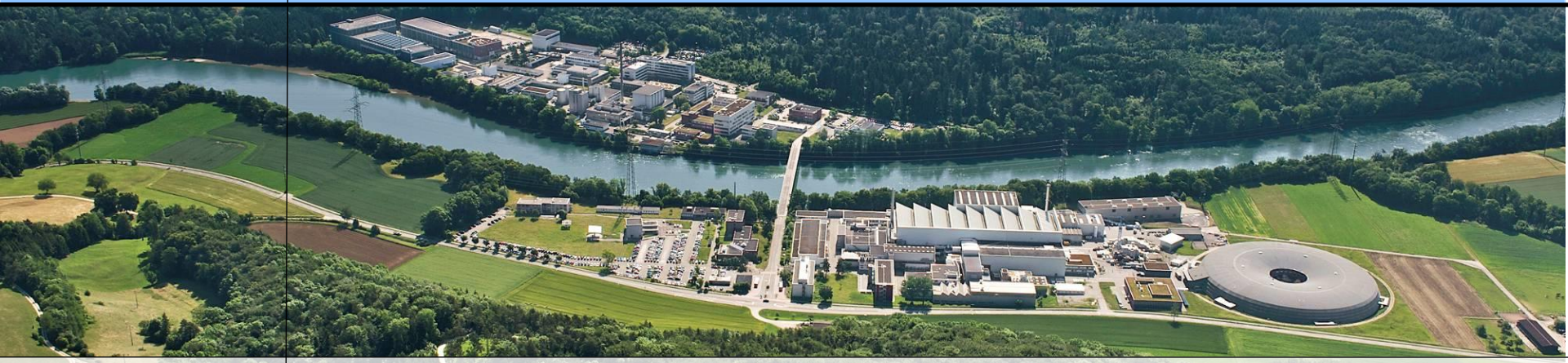
PAUL SCHERRER INSTITUT

PSI



Wir schaffen Wissen – heute für morgen

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EPICS V4 Archiver Service and Matlab client

Timo Korhonen

Overview

- ArchiverService
  - To access Channel Archiver data using pvAccess RPC
  - Written by James Rowland and David Hickin (Diamond)
- Client code to access the ChannelArchiver service from Matlab
  - Written by me to
    - Have a tool to access the service
    - Learn how to write client code
  - Used Matlab because
    - Matlab is a central tool for our SwissFEL project
    - Java API can be directly used
    - Quick cycle for testing (scripting)
- Disclaimer: these slides are basically the same that presented in May'13 EPICS meeting
  - Sorry if you have already seen this once!

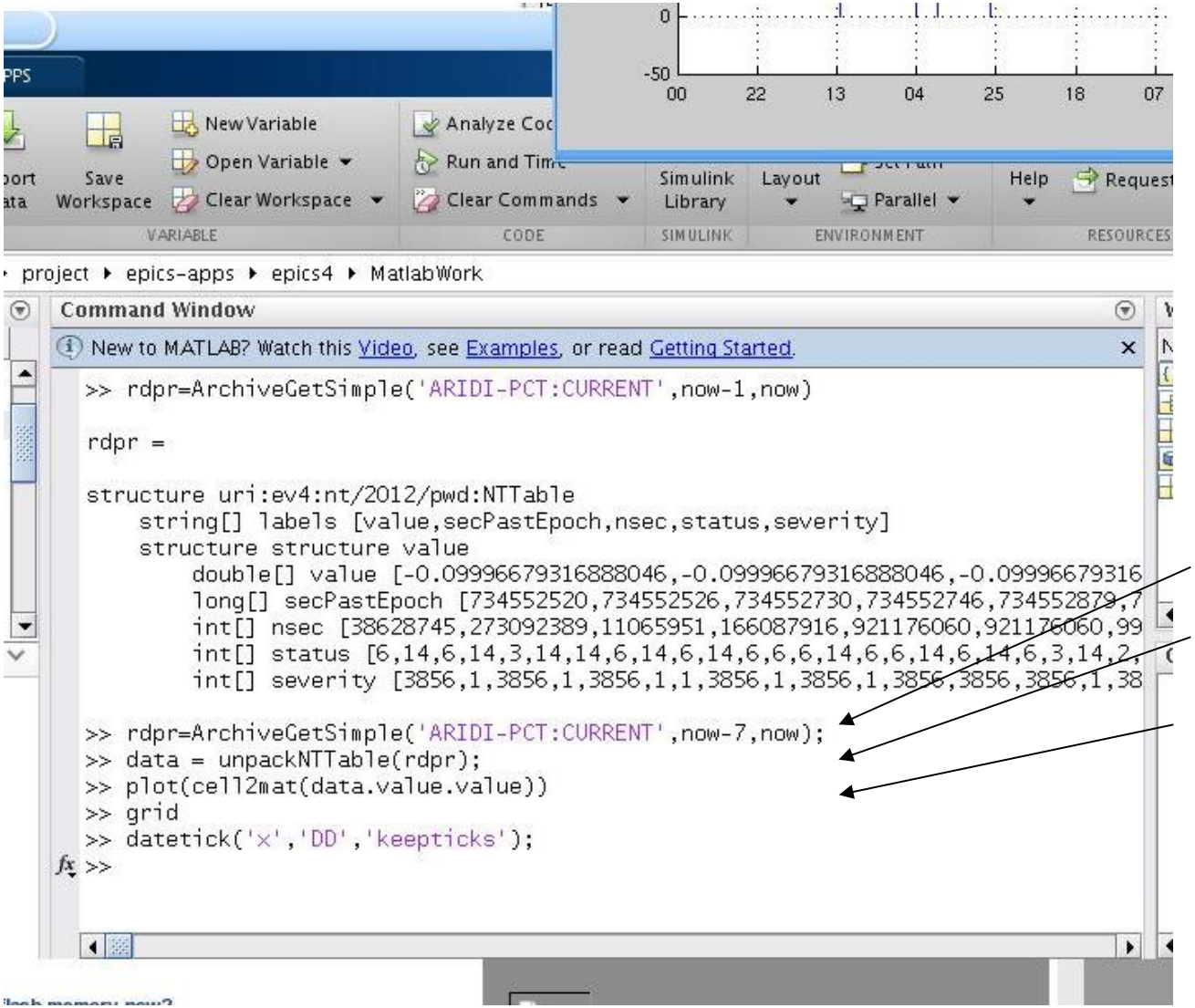
Archive Service

- ArchiverService
  - Many sites are still using the Channel Archiver (PSI and Diamond at least)
  - Direct access to the data would be valuable
  - Implement access to the data as a V4 service
  - One of the first services that was developed and deployed
- Basic mode of operation:
  - Use the RPC method that pvAccess provides
  - Client sends a query to a server, with parameters
  - Server fetches the data, packs it up and sends to the client
  - Client receives the data, unpacks the structure and (in this case) returns the data as a Matlab native structure
  - The Java API can be used natively in Matlab
    - No wrappers in between
    - Some conversions between Java structures and Matlab structures required, however

Anatomy of a channelRPC in EPICS V4

- RPC is a pvAccess operation that can take parameters
  - In the archive service case:
    - Channel to be retrieved
    - From <start time> to <end time>
  - These parameters are sent to the server as a structure
- Use the NTURI normative type to send parameters
    - The client creates this structure and sends it to server
  - Server advertises a channel name that the client connects to
    - Basic connection mechanism is similar to channel access:
      - Search broadcast, server that has the name, replies, etc.
      - After that the differences start....(introspection, etc.)
  - Server receives the structure from client and
    - unpacks the parameters, fetches the data from archiver
    - Packs the data into another normative type structure (NTTable) and sends
  - Client receives the data and unpacks it

The code...



What the user sees...

ArchiveGet call

Unpacking the data

Plotting, etc. or whatever the user then wants to do with the data

Let us look inside these functions

The code...

```
function rdpr = ArchiveGetSimple( pvname, starttime, endtime )
%ArchiveGetSimple get data from archiver service into a pvData structure
%   Detailed explanation goes here

import('org.epics.pvaccess.*')
import('org.epics.pvaccess.easyPVA.*')
import('org.epics.pvdata.*')
%
request.scheme='pva';
request.path='SLS-LT'; %hardcode for now - replace later
request.query={'starttime',starttime;'endtime',endtime;'entity',pvname};

%start the EasyPVA factory
easy = EasyPVAFactory.get();
pvr=BuildRPC(request);
% now do the query
rdp=easy.createChannel(request.path).createRPC();
%created an EasyRPC, now connect
rdp.connect();
% do the request. Result is a PVStructure object
rdpr = rdp.request(pvr);
%now the result is in structure rdpr.
end
```

This is just a wrapper around pvAccess and pvData calls

Import the Java classes

Create a Matlab structure for the request

The actual pvAccess things are here

The request call returns a NTTable (Java structure) ; rdpr
This is returned to the caller

The code: creating a RPC query structure

```
function pvr = BuildRPC( request )
%BuildRPC Build a PVStructure for making a RPC call (EPICS 4)
%   pvr = BuildRPC(request)
%   request is a Matlab struct that contains the query data
%   namely: scheme, path and query
%     scheme: pva
%     path: the service name (EPICS 4 PV name)
%     query: query parameters, service-dependent
%   pvr is the NTURI PVStructure
% For RPC queries, the NTURI normative type is used.

if(isfield(request,'scheme') && isfield(request,'path') &&
isfield(request,'query') )

    % uses pvdata
    import('org.epics.pvdata.*')
    %convenience number for possible time calculations
    epicsepoch = datenum(1990,1,1);
...<code continues>
```

BuildRPC creates the NTURI structure for a query

A bit too long to be shown on a slide (82 lines of code, with comments)

-takes data from a matlab structure

-this routine can be used for any service
(only specialty here is how to handle EPICS times: times have to be converted from the EPICS epoch to times that Matlab understands.)

The code: data unpacking

Editor - /afs/psi.ch/project/epics-apps/epics4/MatlabWork/unpackNTTable.m*

EDITOR | PUBLISH | VIEW

ArchiveGet.m | ArchiveViewGui.m | unpackNTTable.m* | ArchiveGetSimple.m

```
function [ table ] = unpackNTTable( inputObj )
%unpackNTTable Unpack an (EPICS4) NTTable to a matlab structure
%   table = unpackNTTable(inputObj)
%    inputObj is an EPICS 4 PVStructure with the normative type (NT)
%    NTTable.
%    table is a matlab cell array
import('org.epics.pvdata.*');
%first we need to check that inputObj is a NTTable
if (strcmp(getNType(inputObj),'NTTable'))
    %get the introspection interface
    str = inputObj.getStructure();
    %names of the fields in the structure
    names = str.getFieldNames;
    if (strcmp(names(1),'labels'))
        %primitive check that the labels are present, thus looks like a
        %NTTable. To be improved.
     lbl =inputObj.getSubField('labels');
     labels=util.pvDataHelper.GetHelper.getStringVector(lbl);
     matlabels=labels.toArray;
     %generate a structure. First for the labels
     table.labels=matlabels;
     % value field. Required
     valfield = inputObj.getSubField('value');
     % fix this: it is allowed to have zero subfields in value struct
     % the code as of now assumes at least one subfield.
     for ind = 1:numel(matlabels)
         vals=valfield.getSubField(matlabels(ind));
         % vals is the data interface
         valsIntro = vals.getField();
         % valsIntro is the introspection interface.
         if(strcmp(valsIntro.getType,'scalarArray')) % matlab wanted me to use strcmp
             if (strcmp(valsIntro.getElementType,'string'))
                 valsArr=util.pvDataHelper.GetHelper.getStringVector(vals);
             elseif (strcmp(valsIntro.getElementType,'double'))
                 valsArr=util.pvDataHelper.GetHelper.getDoubleVector(vals);
             elseif (strcmp(valsIntro.getElementType,'long'))
                 valsArr=util.pvDataHelper.GetHelper.getLongVector(vals);
             elseif (strcmp(valsIntro.getElementType,'byte'))
                 valsArr=util.pvDataHelper.GetHelper.getByteVector(vals);
             elseif (strcmp(valsIntro.getElementType,'boolean'))
                 valsArr=util.pvDataHelper.GetHelper.getBooleanVector(vals);
             end
             %some DB column names use characters that matlab does not like in structure name
             %Fish them out and replace with underscores.
             table.(char(names(2).toString)).(regexprep(char(matlabels(ind)),'\W','_'))=cell(

         end
     end
    else
     disp 'invalid NTTable'
     table = [];
     %this was an error. Perhaps I should replace if/else with a try - catch
    end
else
    disp 'not an NTTable!'
```

unpackNTTable Ln 9 Col 42 OVR

Another helper routine: unpackNTTable

-again generic, not specific to any service

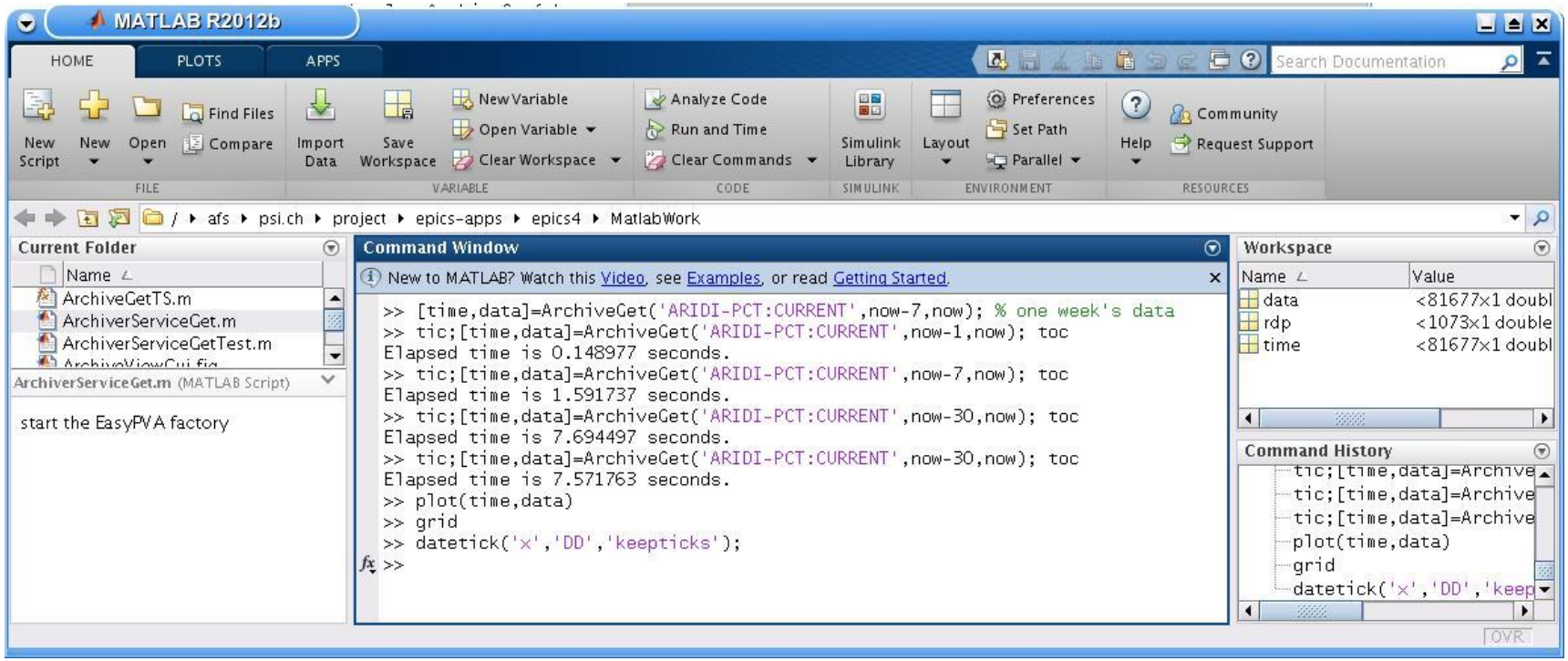
-returns the data in a matlab structure for easy manipulation (plotting, calculations, etc.)

About 60 lines of code (with comments, 40 without)

Remarks about the code

- The shown code is to demonstrate programming
- Improvement ideas for the client code:
  - User does not need to know the data source, just get a value of a PV.
    - Combine archived and live data transparently
      - If “end time” is “now”, get live value and add it to the returned data
      - This needs some changes to the service
        - NTTable does not include channel metadata
        - Either add metadata to NTTable or
        - Use another normative type
  - Use generic routines, not “ArchiveGet”
    - pvget(pvname, starttime, endtime)
    - Doable, but needs a bit more effort.

Some screenshots

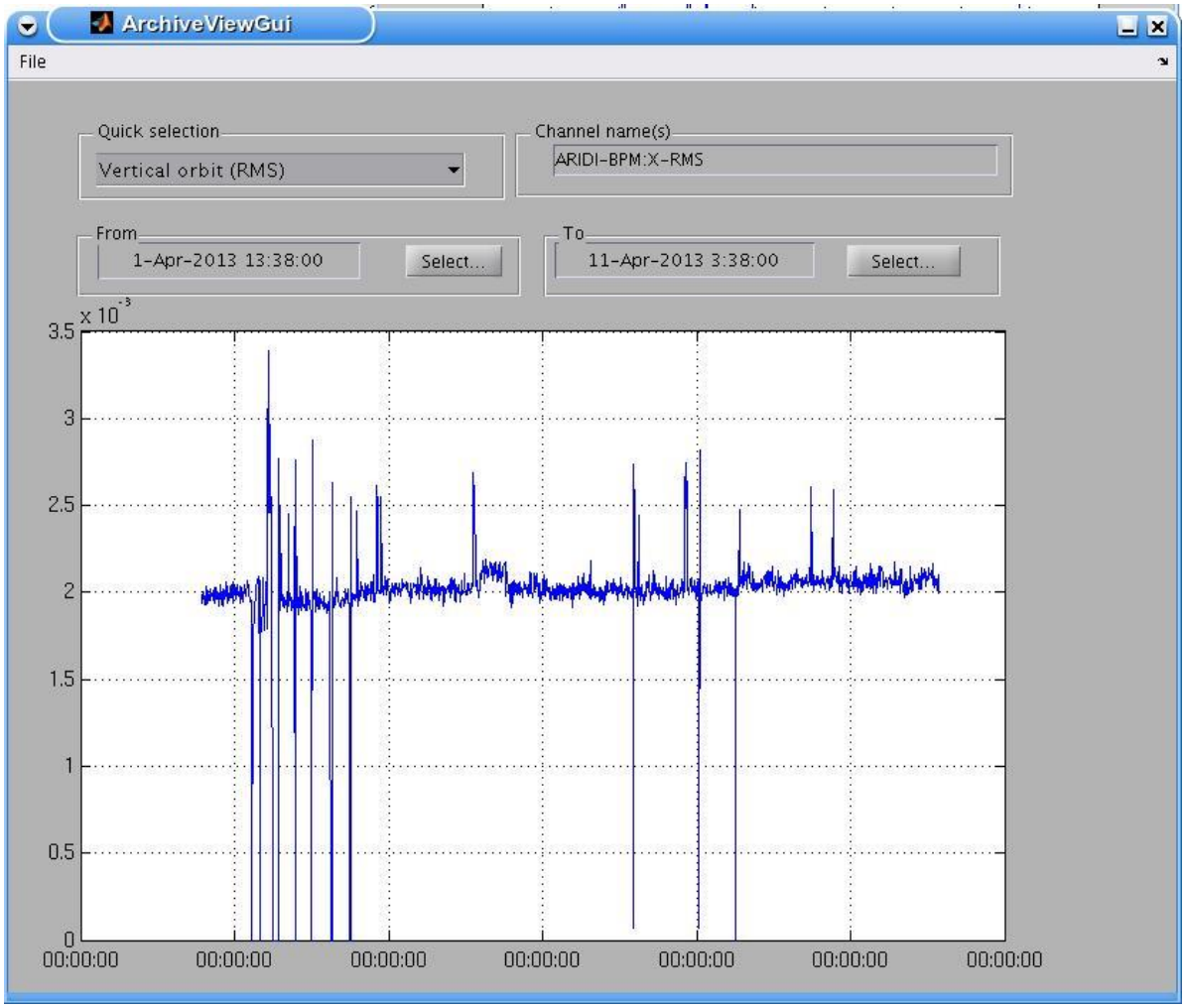


Some timings:

-get one day's data (beam current): **0.15 seconds**
-one week's data: **1.5 seconds**
-one month's data (81677 values): around **7 .5 seconds**

-most of the time is Matlab structure manipulation (I have not profiled the code, however)

Some screenshots



Beginnings of a GUI (matlab)

Fetch the data from archive and plot

This is still at a primitive state, but nevertheless fun to play with

Define a channel, or select one from a predefined set
*the idea is to get the channel names from a service – not implemented yet

Define start and end times

(demo would be nice, but using Matlab remotely can be risky – and slow)

Summary

- ArchiverService
  - Works very well (stable, fast)
  - Needs still some extensions (add waveforms, display information)
- Programming with V4 pvData, pvAccess
  - There is a learning curve, can be steep at times
  - But: when you get familiar with the programming, it is very efficient and productive
  - Opens up **a lot** of new possibilities
  - Normative types are a key aspect: even if they do not look very sexy in the beginning, you will eventually love them :-)
- Services programming
  - Once you have learned how to do one, creating more services becomes easy
  - This is a very efficient way of data integration
    - One set of tools for all data
    - Combining data from different sources becomes easy
- Final disclaimer
  - The code shown is from a beginner – anybody interested is welcome to have it, but it is by no means production-ready. Use at your own risk.